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(54) SOLID-STATE IMAGING ELEMENT AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To control the capacity between a gate electrode and a light screening film by properly controlling the shape of an inner lens.
SOLUTION: A gate electrode 20 for driving a transfer register via an insulation film 10A, a lens-like control insulation film 30 and a light-shielding film 40 for light screening of a transfer register are provided on a silicon substrate 10 provided with a photosensor and a transfer register. An insulation film 50A and a high refractive index film 50B, constituting an inner lend 50, are further provided to an upper layer thereof. A lens shape in the inner lend 50 can be changed, and the incidence characteristic of light to a photosensitive part can be selected by properly changing the film thickness of the lens-like control insulation film 30. The lens-like control insulation film 30 can control an electrostatic capacity between the gate electrode 20 and the light-shielding film 40 and operating characteristics of a transfer register can be improved.

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CLAIMS

[Claim(s)]

[Claim 1] The gate electrode which prepares two or more photosensors which constitute a light-receiving picture element part in a semi-conductor substrate, and the transfer register which transmits the signal charge accumulated in each photosensor, and drives said transfer register on said semi-conductor substrate, In the solid state image sensor which prepared the light-shielding film which regulates the incidence of the light to said gate electrode, and prepared the internal lens which controls the incidence of the light to said photosensor in the upper layer The solid state image sensor characterized by what the insulator layer for lens configuration control which has the thickness of the arbitration for controlling the lens configuration of said internal lens was prepared for in the upper part of said gate electrode.

[Claim 2] Said gate electrode is a solid state image sensor according to claim 1 characterized by being formed in self align by using the insulator layer for lens configuration control as a mask.

[Claim 3] Said insulator layer for lens configuration control is a solid state image sensor according to claim 2 characterized by consisting of the 1st insulator layer formed of lithography and etching, and the 2nd insulator layer which was formed so that said 1st insulator layer might be covered, and was formed so that it might remain only in the side attachment wall of the 1st insulator layer by anisotropic etching.

[Claim 4] The solid state image sensor according to claim 1 characterized by controlling the lens configuration of said internal lens formed in the upper layer by the level difference formed on a semi-conductor substrate, and controlling the focal distance of an internal lens by said gate electrode, the insulator layer for lens configuration control, and the light-shielding film.

[Claim 5] The 1st process which forms the electric conduction film used as a gate electrode on a semi-conductor substrate, and the 2nd process which forms the 1st insulator layer which has predetermined thickness on said electric conduction film, The 3rd process which forms the insulator layer for lens configuration control by leaving and removing the part corresponding to the up field of said gate electrode for said 1st insulator layer, The 4th process which processes said electric conduction film by using said insulator layer for lens configuration control as a mask, and forms a gate electrode, The manufacture approach of the solid state image sensor characterized by having the 5th process which forms a light-shielding film in the upper layer of said gate electrode and the insulator layer for lens configuration control, and the 6th process which forms an internal lens in the upper layer of said light-shielding film.

[Claim 6] The process which forms the main insulator layer section of the insulator layer for lens configuration control which said 3rd process leaves and removes the part

corresponding to the up field of said gate electrode for said 1st insulator layer, and has a pattern a little smaller than a gate electrode, The process which forms the 2nd insulator layer in the upper layer of said main insulator layer section for the main insulator layer section in the state of a wrap, The manufacture approach of the solid state image sensor according to claim 5 characterized by having the process which leaves the side-attachment-wall part of said main insulator layer section, removes said 2nd insulator layer, and forms the side-attachment-wall section of the insulator layer for lens configuration control.

[Claim 7] The manufacture approach of the solid state image sensor according to claim 6 characterized by processing the 1st insulator layer by lithography and etching, and processing the 2nd insulator layer by anisotropic etching at said 3rd process.

[Claim 8] The manufacture approach of the solid state image sensor according to claim 5 characterized by having the process which insulates the exposure of said gate electrode when forming a light-shielding film at said 5th process.

[Claim 9] The process which insulates the exposure of said gate electrode is the manufacture approach of the solid state image sensor according to claim 8 characterized by being the process which oxidizes the exposure of said gate electrode.

[Claim 10] The process which insulates the exposure of said gate electrode is the manufacture approach of the solid state image sensor according to claim 8 characterized by being the process which prepares the 3rd insulator layer in the exposure of said gate electrode.

[Claim 11] Said 6th process is the manufacture approach of the solid state image sensor according to claim 5 characterized by including the process which performs reflow processing after preparing the 4th insulator layer which determines the configuration of an internal lens as the upper layer of said light-shielding film.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the solid state image sensor which has the internal lens which controls the incidence of the light to the light-receiving picture element part prepared in the semi-conductor substrate, and its manufacture approach.

[0002]

[Description of the Prior Art] While preparing two or more photosensors, a transfer register for a signal-charge transfer, etc. which constitute a light-receiving picture element part in a semi-conductor substrate with the so-called in-line structure as a solid state image sensor using the conventional CCD structure, what prepared the gate electrode which drives a transfer register, and the light-shielding film which regulates the incidence of the light to this gate electrode on this semi-conductor substrate is offered. And in such a solid state image sensor, the electrode layer using ingredients, such as polycrystalline silicon, as an approach of forming the gate electrode of a transfer register is formed on a semi-conductor substrate, for example, this is processed with a lithography technique, and a desired pattern is obtained. Moreover, as an approach of forming a light-

shielding film, an insulator layer made from silicon oxide etc. is prepared on a gate electrode, light-shielding films, such as aluminum and a tungsten, are formed on this, and a transfer register is shaded.
[0003] And in such a CCD solid state image sensor, the various proposals of the thing of a configuration of having prepared the internal lens in the upper layer of a light-shielding film are made in order to carry out incidence of the light to the light-receiving picture element part by photosensor effectively (reference, such as JP,9-64325,A and JP,11-103036,A). For example, after preparing insulator layers, such as BPSG which determines the configuration of an internal lens as the upper layer of a light-shielding film, a lens configuration is acquired by performing reflow processing.
[0004]
[Problem(s) to be Solved by the Invention] However, in the above-mentioned conventional example, when preparing an internal lens on a light-shielding film, the configuration of the insulator layer formed on a light-shielding film will be influenced by the level difference produced not only with the membrane formation condition but with a gate electrode, a desired configuration is not necessarily acquired, and it may not be in a good condensing condition. Moreover, although the electrostatic capacity decided by thickness of the insulator layer arranged among both occurs between a gate electrode and a light-shielding film, in case an electrical potential difference is impressed and driven to a gate electrode, the so-called propagation delay which requires time amount by impression of an electrical potential difference from a periphery in the core of an image sensor with this electrostatic capacity may occur.
[0005] Then, while the purpose of this invention can control the configuration of an internal lens proper, it is also to control capacity between a gate electrode and a light-shielding film to offer a possible solid state image sensor and its manufacture approach.
[0006]
[Means for Solving the Problem] Two or more photosensors which constitute a light-receiving picture element part in a semi-conductor substrate in order that this invention may attain said purpose, The gate electrode which prepares the transfer register which transmits the signal charge accumulated in each photosensor, and drives said transfer register on said semi-conductor substrate, In the solid state image sensor which prepared the light-shielding film which regulates the incidence of the light to said gate electrode, and prepared the internal lens which controls the incidence of the light to said photosensor in the upper layer It is characterized by preparing the insulator layer for lens configuration control which has the thickness of the arbitration for controlling the lens configuration of said internal lens in the upper part of said gate electrode.
[0007] Moreover, the 1st process at which this invention forms the electric conduction film used as a gate electrode on a semi-conductor substrate, The 2nd process which forms the 1st insulator layer which has predetermined thickness on said electric conduction film, The 3rd process which forms the insulator layer for lens configuration control by leaving and removing the part corresponding to the up field of said gate electrode for said 1st insulator layer, The 4th process which processes said electric conduction film by using said insulator layer for lens configuration control as a mask, and forms a gate electrode, It is characterized by having the 5th process which forms a light-shielding film in the upper layer of said gate electrode and the insulator layer for lens configuration control, and the 6th process which forms an internal lens in the upper layer of said light-shielding film.

[0008] In the solid state image sensor of this invention, the insulator layer for lens configuration control which has the thickness of the arbitration for controlling the lens configuration of an internal lens was prepared between the gate electrode of a transfer register, and the light-shielding film. Therefore, by choosing suitably the thickness of this insulator layer for lens configuration control, and preparing it, the lens configuration of an internal lens can be optimized and it becomes possible to choose the condensing property of the light which carries out incidence to photosensor free. Moreover, the electrostatic capacity generated between a gate electrode and a light-shielding film can be reduced by adjusting the thickness of the insulator layer for lens configuration control prepared between the gate electrode and the light-shielding film to arbitration.
[0009] Moreover, in the manufacture approach of this invention, by the 1st process, the electric conduction film used as a gate electrode is formed on a semi-conductor substrate, and the 1st insulator layer which has predetermined thickness is formed on the electric conduction film at the 2nd process. Next, at the 3rd process, by leaving and removing the part corresponding to the up field of said gate electrode for the 1st insulator layer, the insulator layer for lens configuration control is formed, the electric conduction film is processed by using the insulator layer for lens configuration control as a mask, and a gate electrode is formed by the 4th process. Next, a light-shielding film is formed in the upper layer of said gate electrode and the insulator layer for lens configuration control at the 5th process, and an internal lens is formed in the upper layer of said light-shielding film at the 6th process after this. By such manufacture approach, a gate electrode can be formed in self align by the ability using the insulator layer for lens configuration control as a mask, and the main insulator layer section can be formed by desired thickness.
[0010]
[Embodiment of the Invention] Hereafter, the gestalt of operation of the solid state image sensor by this invention and its manufacture approach is explained. In addition, in the following explanation, although the gestalt of the operation explained below is the suitable example of this invention and desirable various limitation is attached technically, especially the range of this invention shall not be limited to these modes, as long as there is no publication of the purport which limits this invention.
[0011] Drawing 1 (A), (B), and (C) are the sectional views showing the example of the solid state image sensor by the gestalt of operation of this invention, and are the example which prepared the insulator layer for lens configuration control which has thickness different, respectively. The solid state image sensor by the gestalt of this operation forms the gate electrode 20 for driving a transfer register through insulator layer 10A, the insulator layer 30 for lens configuration control used as the description of this invention, and the light-shielding film 40 for shading a transfer register on the silicon substrate 10 which prepared photosensor and a transfer register, and prepares insulator layer 50A and high refractive-index film 50B which constitute the internal lens 50 in the upper layer further. In addition, as shown in drawing 1 (B), the light sensing portion by photosensor, a transfer register, a channel stop field, the read-out gate, etc. are established in the interior of a silicon substrate 10, but since these are the same configurations as usual, explanation is omitted.
[0012] Like illustration, by changing suitably the thickness of the insulator layer 30 for lens configuration control, the lens configuration in the internal lens 50 can be changed, and the incidence property of the light to a light sensing portion can be chosen with the

solid state image sensor of this gestalt. Moreover, the electrostatic capacity between the gate electrode 20 and a light-shielding film 40 can be controlled, and the insulator layer 30 for lens configuration control can improve the operating characteristic of a transfer register. That is, with the configuration of this gestalt, although it is decided by the conventional structure with the thickness of an interlayer insulation film, since the electrostatic capacity between a gate electrode and a light-shielding film has the insulator layer 30 for lens configuration control in addition to an interlayer insulation film, it can reduce electrostatic capacity.

[0013] Next, drawing 2 and drawing 3 are the sectional views showing the manufacture approach of the solid state image sensor by the gestalt of operation of this invention. First, in drawing 2 (A), the 1st insulator layer 32 by the silicon oxide which forms the electric conduction film 22, such as polycrystalline silicon used as the gate electrode 20, on insulator layer 10A of a silicon substrate 10, next has predetermined thickness on the top face is formed. Here, a growth rate forms membranes early using ordinary pressure chemical vapor deposition with high productivity etc. Based on the thickness of this 1st insulator layer 32, the thickness of the insulator layer 30 for lens configuration control is determined. Next, in drawing 2 (B), lithography and etching leave and remove the part corresponding to the up field of a gate electrode for the 1st insulator layer 32, and main insulator layer section 30A of the insulator layer 30 for lens configuration control which has a pattern a little smaller than a gate electrode is formed. Next, in drawing 2 (C), the 2nd insulator layer 34, such as silicon oxide, is formed in the upper layer of main insulator layer section 30A for this main insulator layer section 30A in the state of a wrap.

[0014] Next, in drawing 2 (D), it leaves the side-attachment-wall part of main insulator layer section 30A, anisotropic etching removes the 2nd insulator layer 34, and side-attachment-wall section 30B of the insulator layer 30 for lens configuration control is formed. Next, in drawing 2 (E), it etches by using as a mask the insulator layer 30 for lens configuration control which consists of the above main insulator layer section 30A and side-attachment-wall section 30B, the electric conduction film 22 is processed, and the gate electrode 20 is formed. According to such a process, it is possible to form the gate electrode 20 in self align, if the pattern of main insulator layer section 30A is formed with lithography limit size, the clearance between gate inter-electrode can be made detailed rather than lithography limit size by side-attachment-wall section 30B, and charge transfer efficiency can be improved. In addition, like this example, by the 2nd insulator layer 34, preparing side-attachment-wall section 30B can also process the gate electrode 20 by using only main insulator layer section 30A as a mask rather than it is indispensable.

[0015] Next, the outcrop of the gate electrode 20 is insulated in drawing 3 (F). This is performed by forming an interlayer insulation film (the 3rd insulator layer) 60 in the upper layer of the gate electrode 20 and the insulator layer 30 for lens configuration control like illustration, or oxidizing the exposure of the gate electrode 20. And while forming the light-shielding films 40, such as aluminum and a tungsten, in the upper layer of this gate electrode 20 or the insulator layer 30 grade for lens configuration control and shading a transfer register, opening of the opening corresponding to a light-receiving field is carried out. Next, in drawing 3 (G), 4th insulator layer 50A which constitutes the internal lens 50 is further formed in the upper layer, and a lens configuration is formed. That is, after preparing insulator layers, such as BPSG which contains boron and

phosphorus by predetermined concentration, a lens configuration is acquired by performing reflow processing. Under the present circumstances, the lens configuration by reflow processing will be determined by thickness of the insulator layer 30 for lens configuration control.

[0016] Next, in drawing 3 (G), restoration spreading of the high refractive-index ingredient is carried out, and high refractive-index film 50B is prepared in the upper layer of insulator layer 50A. Organic materials by plasma chemistry-vapor growth, such as a silicon nitride film and polyimide, are used for the high refractive-index ingredient embedded on this internal lens 50. The level difference produced after the membrane formation which used the silicon nitride film can carry out flattening by performing etching, after applying a photoresist. Moreover, with an organic material, flattening of the front face can be carried out by applying with a spin coat method. By this approach, although it is used a convex in the bottom and an internal lens is used as a flat pattern in a top, after forming a micro-lens pattern by the photoresist after a high refractive-index ingredient embedding, by performing etching, it can also be made a convex type in the bottom and can also be made a concave in a top. Moreover, a high refractive-index ingredient cannot be used for an internal lens, but it can also embed with the ingredient of the same refractive index as the interlayer insulation film on a light-shielding film itself, or an interlayer insulation film. In this case, since the internal lens effectiveness is lost, it is necessary to form a light-shielding film at the include angle which carries out incidence to the light sensing portion which incident light reflected on the light-shielding film front face, and this can be controlled by the configuration of side-attachment-wall section 30B. PASSHI **-SHON which is not illustrated or the flattening film, a color filter, a micro lens, etc. are further formed in the upper layer after such a process, and a CCD solid state image sensor is completed.

[0017] In the solid state image sensor by the gestalt of these above operations, after forming the insulator layer 30 for lens configuration control of desired thickness on the electric conduction film, an internal lens configuration can be optimized by processing the gate electrode 20. Moreover, since the electrostatic capacity between the gate electrode 20 and a light-shielding film 40 can be reduced, **** delay of the component core by CCD solid state image sensor enlargement and the formation of pattern detailed of a gate electrode can be prevented. moreover, by the manufacture approach of the solid state image sensor by the gestalt of this operation Since the gate electrode 20 can be formed by self align by using the insulator layer 30 for lens configuration control as a mask, If the pattern of main insulator layer section 30A by the 1st insulator layer 32 is formed with lithography limit size, rather than the lithography limit size by side-attachment-wall section 30B by the 2nd insulator layer 34, the clearance between the gate electrodes 20 can be made detailed, and charge transfer efficiency can be improved.

[0018]

[Effect of the Invention] As explained above, in the solid state image sensor by this invention, the insulator layer for lens configuration control which has the thickness of the arbitration for controlling the lens configuration of said internal lens was prepared in the upper part of a gate electrode. Therefore, in the solid state image sensor of this invention, by choosing suitably the thickness of the insulator layer for lens configuration control, and preparing it, the lens configuration of an internal lens can be optimized and it becomes possible to choose the condensing property of the light which carries out

incidence to photosensor free. Moreover, the electrostatic capacity generated between a gate electrode and a light-shielding film can be reduced by adjusting the thickness of the insulator layer for lens configuration control prepared between the gate electrode and the light-shielding film to arbitration.

[0019] Moreover, by the manufacture approach of the solid state image sensor by this invention, after forming the electric conduction film used as a gate electrode on a semi-conductor substrate, the 1st insulator layer which has predetermined thickness is formed on this electric conduction film, and the insulator layer for lens configuration control is formed by leaving and removing the part corresponding to the up field of a gate electrode for this 1st insulator layer. And by using this insulator layer for lens configuration control as a mask, the electric conduction film is processed, a gate electrode is formed, and it was made to carry out sequential formation of a light-shielding film and the internal lens at that upper layer. Therefore, in the manufacture approach of this invention, since a gate electrode can be formed by self align by using the insulator layer for lens configuration control as a mask, by forming the pattern of the main insulator layer section by the 1st insulator layer with lithography limit size, the clearance between gate inter-electrode can be made detailed, and charge transfer efficiency can be improved.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing the example of the solid state image sensor by the gestalt of operation of this invention, and is the example which prepared the insulator layer for lens configuration control which has thickness different, respectively.

[Drawing 2] It is the sectional view showing the manufacture approach of the solid state image sensor shown in drawing 1 .

[Drawing 3] It is the sectional view showing the manufacture approach of the solid state image sensor shown in drawing 1 .

[Description of Notations]

10 [.. The main insulator layer section 30B / .. The side-attachment-wall section, 32 / .. The 1st insulator layer, 34 / .. The 2nd insulator layer, 40 / .. A light-shielding film, 50 / .. Internal lens] .... A silicon substrate, 20 .. A gate electrode, 30 .. The insulator layer for lens configuration control, 30A